How can environmental sustainability improve through digital transformation? An explorative analysis in the agri-food system.

Abstract:

Purpose of the paper*: The research aims to analyse the enabler role of digital technologies for enhancing the stakeholder engagement to achieve corporate environmental sustainability in the agri-food system. Particularly, digital stakeholder engagement coupled whit sustainability objectives retaled to EU taxonomy are investigated.*
Methodology*: A multiple case study and a cross case analysis were adopted to analyse which digital technologies have been implemented into cases companies for the purpose of environmental sustainability and for investigating mechanisms activated by digital transformation.*
Main Findings*: The paper demonstrates how digitalization enhance stakeholder engagement. Moreover, they reveal to support the pursuing different sustainability objectives related to UE sustainability taxonomy.*
Practical implications*: The study points out the need for agri-food firms to incorporate environmental sustainability into the digital transformation strategy and to proactively involve stakeholders.*
Originality/value*: Despite the literature has already pointed out the positive relationship between stakeholder engagement and sustainability objectives, the paper contributes to investigate the role of digital technologies in enhancing stakeholder engagement for sustainability.*
Type of paper*: Research paper*

Keywords*: Digital Technologies, Stakeholder engagement, Environmental Corporate Sustainability, Agri-food system*

1. Introduction

The world of businesses is changing in drastic ways. Nowadays, the need for socio-economic organizations to take into the account environmental issues is clearly urgent, due to climate changes the world is already going through (Wright et al., 2017). In this scenario, organizations have come to adopt a corporate view that highlights and embraces the objectives of environmental sustainability as imperatives for long-term success (Ones et al., 2012). The topic of sustainability and sustainable development is a top priority of many governments' agendas that have outlined the urgency to intervene (European Commission, 2020; United Nations, 2020; World Bank, 2020). At this regard, European Union has fixed six main environmental sustainability targets to identify economic activities as more sustainable.

Since organizations act in a social and business environment in which they interact each other and with different actors, such as employees, suppliers, global and local communities, it is relevant to analyse how organizations could enhance sustainable performances through the engagement of different stakeholders. Stakeholder engagament can be seen as the firm's ability to establish collaborative and cooperative relationships with a wide variety of actors (Rueda-Manzanares, Aragón-Correa, & Sharma, 2008; Zwikael, Elias, & Ahn, 2012). It includes a set of initiatives or practices that organizations develop to positively engage stakeholders in their organizational activities (Greenwood, 2007) and can inspire and reward fundamental changes to core operations of the firm that are beneficial both to the natural environment (Sulkowski et al., 2018) and to the firm ability to create value (Loureiro et al., 2020). Indeed, organizations which take care of their stakeholders are more willing to shape new ways of creating value, because they are able to promote new collaborations and partnerships, improving access and exchange of resources (Lourenço et al., 2014).

In a more a more digital world, new technologies such as cloud computing, mobile computing, big data analytics, artificial intelligence, blockchain, machine learning, Internet of Things (IoT), cyber-physical systems, represent a huge opportunity to allow the design of a sustainable path that organizations have to take. Digital transformation is triggered and shaped by the widespread diffusion of the afromentioned digital technologies and refers to sociotechnical processes of digitization application at organizational, social, and istitutional levels (Ciasullo et al., 2021). Thus, digital trasformation and related digitization processes can be a relevant driver of sustainability providing new value opportunities for transformative changes. However, despite the extensive literature about corporate sustainability (Shams et al., 2020; Matikainen, 2022; Jang, 2022), to date scholars paid little attention on how organizations can exploit synergies in the digital transformation processes to achieve sustainability related goals. A recent systematic literature review explicitly confirms that in management literature sustainability is an insufficiently discussed field of application for digital technology (Guandalini, 2022). Accordingly, it is relevant to focus on which technologies are implemented in order to converge towards a sustainable organization. Moreover, it is necessary to pay attention on how stakeholder engagement could support environmental sustainability through digitization. Since the pursuing of sustainability objectives, particularly environmental ones, is an efforting goal, it is required a systemic vision in which nature, society and businesses are strongly intertwined thus requiring the proactive involvement of stakeholders both within and beyond the business environment, thereby shaping a digital sustainable ecosystem.

In particular, among different industrial contexts, the agri-food sector deserves deep attention because it has provoked devastating environmental impact such as pollution, soil erosion, landscape damage, reduction of energy resources, and overall loss of diversity,

both biological and cultural. At this regard, digital technologies could assume a key role to support the agri-food companies to turn towards a sustainable approach. Indeed, since transformation and demand-driven supply chain are the main characteristics that are leading the changes in this industry (Bucci et al., 2019; Hamidi et al., 2018), organizations that operate all along the supply chain struggle with new managerial practices for the pursuing of corporate sustainability, particularly environmental ones.

Therefore, the present study by focusing on the agri-food sector, identifies two main research questions :

RQ1 : Which digital technologies affect environmental objectives?

RQ2 : Which digitized mechanisms of engagement with stakeholders are shaped?

A multiple methodology case studies was used (Yin, 2009), by selecting five organizations in agri-food sector.

The paper contributes to the research advancement of the sustainability management supported by digital transformation. Particularly, in order to detect the objectives of sustainability reached by organizations through digitization, research combines the environmental sustainability taxonomy, by enhancing stakeholder engagement.

The paper has organized as follows: the second section is dedicated to literature review about stakeholder engagement and its bound to environmental sustainability, the third section is focused on methodology, the fourth on findings, the fifth on discussion, the last section is dedicated to conclusions./

2. Literature Review

2.1 Corporate sustainability and digital transformation

Corporate sustainability has become a relevant key goal of organizations, whatever is their industry or country of origin (Porter and Kramer, 2006). This is linked to corporate strategies that allow to introduce the environmental practices in order to satisfy the needs of all current stakeholders without compromising those of future stakeholders (Schrettle et al., 2014). Corporate sustainability as a concept refers to the three pillars of the triple bottom line—social equity, economic efficiency, and environmental performance—embedded into strategic and tactics practices of organizations (Coscieme et al., 2021). Focusing on environmental sustainability, it is defined as the practice of meeting current needs without sacrificing future well-being, preserving values and relationships while managing the scale and speed of change (Horisch, 2014). In essence, this means not to use more resources than social and ecological systems can sustain. This implies the need for organizations to adopt a long-term vision, in order to protect natural environment (Herremans and Reid, 2002). Environmental sustainability is highly complex, because it requires to affect human behaviours and responsability. It consist in involving social and human values to sustain the present and the future natural environment. As a consequence, environmental sustainability is an holistic construct.

Many institutions have manifested the urgency to intervene for shaping organizations more environmentally responsible, for this reason EU have proposed in 2020 the EU Sustainable Taxonomy. Particularly, it has been published in the Official Journal of the European Union on 22 June 2020 and entered into force on 12 July 2020.

This policy provides six environmental objectives, at which organizations should be committed in order to become more climate-friendly.

They are :

- Climate change mitigation;
- Climate change adaptation;

- The sustainable use and protection of water and marine resources;
- The transition to a circular economy;
- Pollution prevention and control;
- The protection and restoration of biodiversity and ecosystems.

For climate change mitigation, EU means net-zero emissions by 2050 and a 50–55% reduction by 2030; for climate change adaptation, EU refers not to lead to a lock-in in assets that undermine long-term environmental goals and to have a substantial positive environmental impact on the basis of life-cycle considerations. Pollution prevention and control, use and protection of water and marine resources, circular economy, and protection and restoration of biodiversity and ecosystems are developed, for EU, in the context of avoiding significant harm (EU, 2020).

These environmental objectives can be supported by the implementation of digital technologies. At this regard, scholars still do not provide a clear consensus that digital technologies have a long-term impact on environmental sustainability (Oláh et al., 2020). In fact, some studies strongly affirm the positive link between environmental sustainability and digital technologies, such as Stock and Seliger (2011) that have argued that digital technologies, particularly Industry 4.0, provide tremendous opportunities to achieve environmental sustainability. Moreover, Burritt and Christ (2016) outline that environmental sustainability is positively impacted by digital technologies through comprehensive digitization that provides more accurate, high-quality management and real-time event management for the external environment.

In other studies, scholars discuss about the challenges for environmental sustainability that come up with the implementation of digital technologies. For example, Ford and Despeisse (2016) and Jelonek and Urbaniec (2019) reveal the presence of several challenges because technologies are still at an immature stage.

As a consequence, the challenges and opportunities associated with the implementation of digital technologies are still uncertain, and the technologies associated with this industry in terms of environmental sustainability have not been adequately explored because these are still new technologies. This is more strongly observed into the agri-food sector, in which the presence of supply chain requires the coordination among different actors (i.e. farmers, logistics, packaging). Then it is more difficult to identify the long-term challenges between the environmental sustainability and digital technologies, because digital technologies affect the whole network. Neverthless, recent studies have outlined that the introduction of technological innovations will become crucial for the survival of agri-food companies (Spanaki et al., 2021).

2.2 Stakeholder engagement via digital technologies

Stakeholder engagement has gained prominence in different areas of business and society research, by letting the researchers to pay attention to this topic (Kujala, 2019). Particularly, stakeholder engagement as a construct has provoked interest for scholars during 1990s (Coff, 1999; Gregory and Keeney, 1994; R. K. Mitchell et al., 1997; Savage et al., 1991; Svendsen, 1998). Stakeholder engagement has firstly been studies as a communication practice (Morsing et al., 2006), thereby confined at a tactical level, then, stakeholder engagement has been analysed as a collaboration practice in which interacting actors share joint interests and goals (Kujala et al., 2019). Nowadays, stakeholder engagament is considered as a key strategic asset for improving value creation (Payne et al., 2020) and for building a competitive advantage (Storbacka, 2019 ; Ciasullo et al., 2021).

It is linked to the overall businesses processes to make stakeholder inner part of organizations, in which internal and external stakeholders affect the activities of the

organization (Sloan, 2009). Accordingly, in a world that is more and more digitalized, stakeholders have become active part in corporate strategies. Indeed, they are no longer considered as external entities from organizations, they are no longer engaged for communication and the deployment of information, but they are collaborators and orchestrators in value creation processes (Davey et al., 2022). Digital technologies have make wider the sources to engage stakeholders, in the searching of partnerships and collaboration with multiple and diverse networks of relationships with socio-economic entities (Payne et al., 2020). Therefore, digital technologies allows stakeholder engagement to be multi-directional, dynamic and networked, with an unprecedented and rapidly growing variety of interactions and connections (Davey et al., 2022).

The literature agrees on considering digital technologies as an enabler of a better stakeholder engagement. In fact, it does not focus only on the role of digital technologies or on the mere implementation of digital technologies, but stakeholder engagement is linked to the role of human empowerment and to the overall socio-technical processes. These processes allow to better cultivate trust and commitment, stakeholder satisfaction, mutual and long-term benefits, sustainable advantage, through socio-technical systems. (Egan, 2000).

3. Methodology

3.1 Research approach

A multiple case study was adopted as an appropriate research design to study novel and contemporary phenomena. This methodology appears to be the most suitable one for the explanatory stage of research, because it allows to gain a lot and rich information. In addition, it is adequate when elements of the study are still not well operationalized, through quantitative variables. Moreover, qualitative methodology allows to "concentrate on the comprehension of the dynamics that characterizes specific contexts" (Eisenhardt, 1989, p. 532), so that the researcher can better describe and understand different situation in a specific context. For our study, it has been selected five cases in the food and beverage sector as explained below.

3.2 Case selection

The work focuses the analysis in the agri-food sector that confirms, in 2020, to be in first place among the "4As" of "Made in Italy", which are food, fashion, furniture and automation. Moreover, it has demonstrated to be a strong sector also during Covid-19. Indeed, it has seen a reduction added value of -1.8% in 2020, compared to -8.9% of the total Italian economy and exports grew by 1.8%, despite the restrictions imposed during the pandemic (The European House, 2020). The agri-food industry has therefore confirmed itself, even in times of crisis, as a pillar of Italian economy.

A theoretical sampling has been identified to select cases that could express how digital technologies contribute to stakeholder engagement in order to reach sustainability objectives. Specifically, the research strategy was based on the following criteria. First, the organizations which are identified by ATECO code as those that operate along the agri-food industry. Second, organizations which have shown interest for environmental sustainability and that have implemented digital technologies. It has been selected 5 organizations, operating at different food supply chain stages, such as Farming, Logistics and Packaging. No explicit reference will be made to the organizations under study to ensure confidentiality. At this end, the organizations are called by following Greek alphabet. Their details are shown in Table 1.

3.3 Data collection

Both primary and secondary data were collected. The last one has been used to allow a better comprehension of the context in which firms operate, in order to better understand the specific contributions of the interviews. As secondary data, it has been used corporate documents, such as presentations, white papers, sustainability reports. As primary data, it has been conducted in depth virtual interviews with organizations' executives (i.e., general manager, chief information manager, sustainability manager, digital marketing manager, technology manager, R&D manager), because they are involved both on the strategic choices about digital transformation for the purpose of corporate sustainability, and on the different stakeholders involved in the corporate digital context.

A semi-structured interview guide was used to obtain information about the different implemented digital technologies, the relations with stakeholders and the interest for the sustainability issues. Open-ended questions were asked, after that the interviewer presented the scope of the study and made the respondents feel relaxed in order to answer freely to the questions. The questions were linked to which digital technologies have been implemented; how digital technologies affect the interaction with stakeholders; how digital technologies enhance stakeholder engagement; which and how stakeholders are involved into the reaching of sustainability objectives, which and how stakeholder sustain sustainability objectives, how sustainability interest is pursued by digital technologies. The interviews lasted on average 45 min and all the answers were audio-recorded and transcribed.

3.4 Data Analysis

It has been first conducted a content analysis, that is defined as "an approach to documents that emphasizes the role of the investigator in the construction of the meaning of and in texts. There is an emphasis on allowing categories to emerge out of data and on recognizing the significance for understanding the meaning of the context in which an item being analyzed appeared" (Bryman, 2004, p. 542). In this study, content analysis has been used identify digital technologies affecting environmental sustainability and to find the main mechanisms activated by digital technologies in enhancing stakeholder engagement and to identify those technologies that allow to improve environmental sustainability. After that, a cross-case analysis has been conducted to determine similarities and/or differences among different companies investigated. (Yin, 2009).

Table 1 : Agree-Food Companies Sample

Firm	*Location*	*Leading product*	*Industry*	*Revenues (€/m)*	*Employees*
Alfa	South	Pasta	Farming	157	203
Beta	South	Perishable Food	Logistics	58	144
Gamma	South	Pasta	Food Package	180	200
Delta	South	Tomato	Farming	705	305
Epsilon	South	Tomato	Food Package	135	180

4. Findings

Alfa, as a farming organization, has implemented digital technologies to shape precision and smart farming, based on a strong commitment to environmental sustainability. This brought *Alfa* to the need to innovate for sustainability, by showing a strong corporate culture. Particularly, *Alfa* has introduced Big Data Analytics in order to support it in making informed decisions and in order to develop management methods to be aware of specific location and crop, to optimize growth conditions and waste. Second, linked to precision farming, *Alfa* introduced drones, that are equipped with sensors. The aim of the usage of drones is to collect data that can be analyzed to make more efficient the use of chemical inputs, like pesticides, and to pay more attention on water use or waste, through drip irrigation. Moreover, drones allow to collect aerial images, so that it is easier to observe problems related to irrigation and changes in soil conditions. Lastly, *Alfa* started using sensors (Internet of Things) for monitoring crop, planting, soil and field analysis, always in an environmental and better production perspective. In order to better manage these technologies, *Alfa* has started a long-term collaboration with several digital local start-ups. They provided technical expertise and specific knowledge to support Alfa for the purpose of environmental objectives. Each start-up has been engaged for different roles. In fact, for example, a start-up is devoted in developing specific algorithm able to recognize the excessive use of pesticides and chemical inputs through the use of drones. Another start up supported Alfa to develop an algorithm to fast process data. These strategic collaborations have increased the possibility to create new integrated value. Indeed *Alfa* has shaped new employees' skills, such as the ability to interpret data, to analyse visual figures from drones, to manage with more awareness water, chemical inputs and soil. At this end, *Alfa* has invested human and digital resources to preserve the natural environment, by considering it as one of the main corporate stakeholders to satisfy.

Beta, the logistics organization, is particularly committed to improve traceability and transparency about products' conditions that are delivered. This comes from business customers, that request for more detailed information regarding the products and their conditions during the transport to be shared with them. In fact, since the products to deliver are perishable, it is necessary to monitor the products transportation and to avoid they reach the customers in bad conditions, in order to cultivate trust among them. At this regard, *Beta* has implemented Big Data Analytics, Internet of Things (IoT), Blockchain and Cloud Computing. Big data Analytics has allowed to build a product traceability, because it permits to collect data in real time. Also IoT is used to track products and to monitor food quality that is delivered. Whereas, Blockchain is used all along the value chain among the diverse stakeholders to improve traceability and trasparence, by increasing the access to information through a standardized technology. Cloud Computing has the aim to inform partners about containers conditions.

Gamma, as a package food organization, implemented on one hand the smart packaging, on the other hand, it developed an interest in packaging recycle technologies. Smart packaging refers to a type of box or packaging with sensors and materials that react to changes that could compromise the correct preservation of the product and helps to monitor the situation of goods in real time. For example, the packaging can highlight if the product has received hits and changes in position that could be harmful or even communicate its location. This technology allows communication between packaging and logistics organizations, so that products arrive to the costumers in great conditions. As regards packaging recycle technologies, *Gamma* collaborates with a local university to innovate in order to accomplish circular economy. At this aim, different experts have been engaged such as chemical researchers, informatics researchers, IT technicians. Thanks to these deep

collaborations, a digital tool has been realized, which allow the production of a packaging entirely bio compostable. Thanks to this green innovation, Gamma has decreased its CO2 emissions. In addition, *Gamma*, through social media has launched a program, in collaboration with environmental associations, to involve users into the collection of plastic bottles, so that they could be reutilized into the packaging process. Moreover, *Gamma* is reutilizing glass scrap as new raw material to be reintroduced into the packaging chain, by also considering that glass can be recycled an infinite number of times without any loss of material.

Delta, as a farming organization, has dedicated effort to converge to an organic farming. For this reason, it launched a digital platform in which promotes organic food, by sharing with ecosystem stakeholders' sustainable practices. Involving the network of ecosystem stakeholders, such as, economic actors (e.g., logistics providers, packaging organizations, raw material supplier), and social actors (universities, local institutions), *Delta* through digital platform, based on standardized interfaces, reduces the interaction barriers, shapes agile interactions, allowing a facilitate access and exchange of information among and between the actors. By taking inspiration by business digital platform, Delta has also launched a digital platform for consumers and users, in order to spread the principles of organic food. This platform is organized to sensibilize users for the building of a healthy food culture. Moreover, in order to implement precision irrigation systems, *Delta* has introduced sensors (IoT). This has allowed to reduce water consumption during production processes. Finally, *Delta* introduced a QR-Code technology to categorize every typology of products. Then, these products are uploaded on the platform, so that users (e.g., suppliers, logistic providers, and packaging companies) can easily access to information and better coordinate their activities.

Epsilon, as package food organization, implemented sensors (IoT) and automated controls to intervene immediately in case of machines disfunctions, so that packaging materials can be saved from wasting. Indeed, it shows a strong commitment for circular economy, deploying technologies in order to reuse or recycle packaging. *Epsilon* has started a close collaboration with local schools to promote the theme of sustainable packaging, to teach students what means working moved by environmental sustainability aims, to make them passionate about ecological responsiveness. These meetings are also finalized to launch a contest for the best environment-friendly packaging among students, so that *Epsilon* could take inspiration by new generations for a better food package. The meetings are organized through an online platform, so that they are more reachable among students from different schools. Moreover, *Epsilon*, in collaboration with environmental associations, has launched a digital platform through which it dialogues with its stakeholders through a standardized interface to share with them the last environmental solutions that research produces.

5. Discussion

As deepened in the previous section, different digital technologies are adopted by the case companies analyzed, also focusing on different stages of food value chain. This let us to identify technologies which contribute to innovate for the environmental sustainability purpose combining the different objectives defined by EU and the digitized mechanisms that are activated in digited context reinforcing stakeholder engagement.

From this study, it emerged that many digital technologies could intervene in order to sustain organizations in becoming more environmentally responsible. Particularly, digital technologies, that support the creation of the smart farming (i.e. *Alfa*), increase the

opportunity to reconfigure the overall business processes. Particularly, smart farming reveals to be the main farming reconfiguration that is able to pursue environmental objectives entirely, because it integrates technologies as Big Data Analytics, Internet of Things, drones that allow to innovate in order to control water consumption for irrigation and products conditions to avoid to waste and to collect data for improving environmental decision making. Precision farming supports the control of drip irrigation, by saving as much water as possible.

In the same way, in the context of packaging companies, smart packaging and recycle technologies an overall reconfiguration of organizational processes towards a circular economy, in which packages become new raw materials for packaging production.

Digital technologies as Big Data Analytics are useful to analyse in which way organizations pollute the most, so that they can contribute to reduce pollution and CO2 emissions and to protect biodiversity. Automated controls, in the same way of sensors, allows the immediate intervention in case of disfunctions. This reduces the possibility to waste products or raw materials.

Blockchain is the technology that allows to share information among the different actors involved, so that communication among each other improves and the facilitate access to information make possible to reduce waste time, to avoid transportation of perishable goods when there is no possibility to storage them in a new deposit, for example. This means avoiding waste food, towards a more environmentally sustainable supply chain.

Finally, the combination of different digital tools, integrated in an assemblage of platforms, allows to pursue environmental objectives in the whole for the sustainable development. Particularly, introducing more integrated systems allow to generally reconfigure and promote innovative business model for the climate change adaptation and mitigation. Table 2 shows the technologies implemented for each case company.

Table 2: Digital Technologies adopted by companies

Digital Technologies Usage	***Food and beverage organizations***				
	α	*B*	γ	*Δ*	*E*
Precision Farming	×				
Big Data Analytics	×	×			×
Drones	×				
Sensors and Internet of Things	×	×		×	×
Blockchain		×			
Smart packaging			×		
Recycling technologies			×		×
Automated controls					×
QR Code				×	

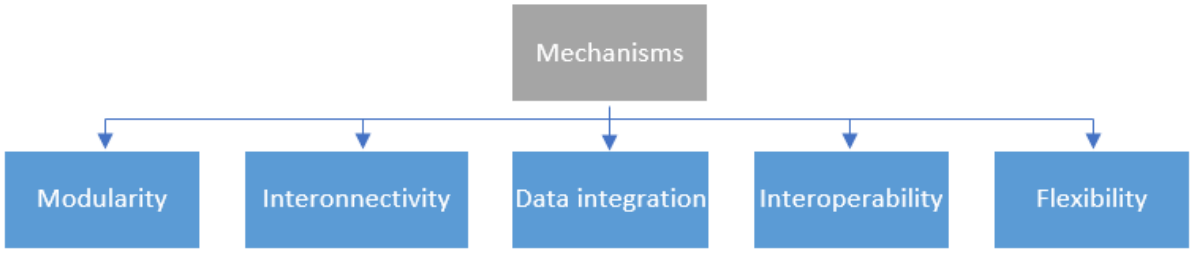
Legenda: Alfa ('α'), Beta ('β'), Gamma ('γ'), Delta ('δ'), Epsilon ('ε')

Every case studied shows an active involvement of stakeholders, considering them as a strategic asset, which they become collaborators and inner part of organizations. For this reason, organizations develop relational strategies to engage and to cultivate interactions with stakeholders both internal and external. From this study, it emerges how the implementation of digital technologies effectively support the acceleration of stakeholder engagement among several stakeholders, such as suppliers, digital providers start-ups, employees, universities. This study proposes to understand how digital technologies accelerate stakeholder engagement, by analyzing mechanisms that are activated. From the

cross-case analysis, it emerges that the implementation of digital technologies intervenes effectively as an enabler of the improvement of the quality of stakeholders relations. Indeed, digital technologies, such as digital platforms and Blockchain, allow to interconnect stakeholders in a more effective way. In this case, information becomes more reachable, it is safer because it avoids human errors communication, whereas it promotes exchanging and share information each other digitally. In fact, network connectivity is linked to "the extent to which various systems within and between different firms are connected for the sharing of information" (Schiavone, 2022). The improvement of stakeholders connectivity is directly linked to relations among stakeholders that appear to be more adaptable, more agile, more resilient, also facilitating the investigated firm in managing the extensive relationship within and beyond the supply chain (Rai et al., 2006). Interconnectivity brings to the spread of environmental principles among business stakeholders and consumers. This emerged particularly in companies that have implemented market place platforms and online tools (i.e. Gamma, Delta and Epsilon). In these cases, digital technologies are used to sensibilize stakeholders for different environmental issues, such as organic food or sustainable packaging, by involving them in a responsible consumption.

Digital technologies increase interoperatibility, by affecting efficiency and effectiveness inside and outside the digital network (Ciasullo, 2021). Digital platforms, Blockchain and QR-Code are technologies that allow the sharing of values among involved stakeholders, because they make data more trackeable and transparent through standardized data and logical coding schemes, so that data become more accessable e usable real time. This corresponds to data integration, that sharing data, allows to build information and knowledge among diverse stakeholders, by accelerating decision making process. Data integration is directly linked to the flexibility of the network, because the acquisition of data in a standardized way allows to process data faster. This means that sharing common standards enhance the information compatibility among diverse stakeholders, by making decisions more flexible. Moreover, digital technologies build an high level of modularity, because the huge level of openness, malleability and generativity requires a constant dialogue with stakeholders into networks, by bringing product, process, and social innovations (Caporuscio et al., 2020, 2021). Figure 1 identifies the enabling mechanisms that contributes to enhance stakeholder engagement through digital technologies.

Figure 1 : Mechanisms activated by digital technologies



6. Conclusions

This study explores the crucial role of digitalization and its transformation process for achieiving sustainable goals in the Italian agri-food sector. Particularly, the cross-case

analysis outline that all the firms are highly committed to and involved into the transformative process brought by digital technologies. At this end, socio-technical processes are strategically managed by collaboration and partnership leveraging knowledge sharing and learning coming from the different stakeholder engaged.

The research provides both theoretical and managerial implications. As regards theoretical implications, it contributes to the rising literature about environmental sustainability in the agri-food sector, by showing how different digital technologies can impact more or less intensively environmental objectives defined by EU. Moreover, the study tracks the link between digital technologies and stakeholder engagement, by identifying five main mechanisms that are activated by digital technologies. In this way, stakeholder engagement is enhanced.

As regards managerial implications, the study points out the need for firms to re-shape their overall organizational processes to shape a digital sustainable ecosystem. Consequently, the purpose to integrate environmental sustainability brings to innovate business processes as well as organizational ones by sustain strategies in which stakeholders are considered inner part. Thanks to the way digital technologies are implemented, stakeholders are more embedded into organizations, by becoming strategic players who contribute to environmental objectives.

As in all studies, there are certain limitations that should be pointed out, in order to make suggestions for future research. First, the adoption of case study methodology does not permit the extension of the findings obtained to other contexts. For this reason, to assess the generalizability of the framework, comparative case studies can be performed. Second, multiple cases study has been focused on one only sector, it should be interesting to make deeper research of stakeholder engagement and sustainability in other sectors which characterized Made in Italy, such as fashion, furniture and automation. This could make the knowledge wider about the most relevant italian sectors in the world. Third, since this study focuses mainly on the supply chain, it could be useful to take in analysis B2C, in order to analyse how digital technologies are used to enhance consumers engagement and study if the same mechanisms are activeted or they change. Finally, this would make findings more reliable and this could be a way to generalize results both in B2B and in B2C digitized contexts.

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